Zero Emission Vehicle Credits

China Program Design Inputs Brief

Innovation Center for Energy and Transportation

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This brief is meant to inspire Chinese EV stakeholders to converse on the topic of ZEV program design and action plan for China. A former *i*CET report described the California ZEV program, evaluated its effectiveness through qualitative and quantitative research, and studied its history and inception process. This former work was introduced to national and local stakeholders in China, including the government, academic, and private sectors through workshops, roundtables and meetings. The process of stakeholders' engagement was important on its own, as it unveiled concerns and challenges facing a China-tailored program. These topics are presented in this brief.

Background

Last year, President Xi Jinping stated new energy vehicles are necessary to strengthen China's automotive industry. Recently, the "Made in China 2025 plan" (中国制造 2025) anchored energy saving and new energy vehicles as one of China's 10 key sectors that should be at the forefront of development for the coming 10 years. The years 2013 and 2014 saw an increase in the number of national and local policies that encouraged the development of the NEV industry, recognizing its important role in China's air quality improvement strategy.

China started its "10 cities, 1000 vehicles" program six years ago, creating pilots cities to demonstrate the potential of EVs, their market feasibility, and challenges. Although the program quickly expanded to include 39 cities, and arguably laid the foundation for the initial development of the industry, the 2015 smog reduction targets declared in early 2013 still poses a great challenge.. Furthermore, because the vast majority of NEVs to date are vehicles for municipal or public use, major efforts are needed. For example, the acceleration of mass private NEVs requires new creative policies that go beyond government demand-subsidies to target open-source infrastructure available to the general public, create efficient private infrastructure installations processes, and build consumer awareness and acceptance of NEVs as a family's first car. It has become clear to local decision makers that subsidies are not a long-lasting solution nor will they suffice in creating the desired mass NEV market. Supply-side incentives attempting to provide justification for the electric car business-case may be successful in engaging big auto manufacturers, and may therefore be instrumental for unlocking current holdbacks. The case of California's ZEV credits, which positioned California as the world's largest EV sales and innovation hub, presents a useful experience and a potential opportunity.

To combat vehicle emissions, California proposed the Zero Emission Vehicle (ZEV) program in 1990 and started formal implementation in 1998. The program has since been extended to nine more states,

covering 23% of the US new car market. California, following constant engagement with EV manufacturers and the auto industry as a whole, is aiming at 15.4% ZEVs of the state's total passenger vehicle sales by 2025, of which as much as half would be pure electric cars (PEVs) and the rest would be plug-in hybrid cars powered by fuels other than electricity part of the time. By 2050, the entire new vehicle market would be comprised of zero and near zero emission vehicles (PHEV), according to government long term goals.

Annual new plug-in electric vehicle registrations and market share in California by type of plug-in (2010 - 2014)[1]

Year	California[164]						United States[6][7][168][169]		CA share of U.S. PEV sales[3]	Ratio CA/US market shares
	All-electric	BEV market share[1]	Plug-in hybrid	PHEV market share[1]	Total PEV California	PEV market share[1]	Total PEV sales	PEV market share[2]		
2010	300	0.0%	97	0.0%	**397**	0.0%	**397**	0.003%	**100%**	-
2011	5,302	0.4%	1,682	0.1%	**6,984**	0.5%	**17,821**	0.14%	**39.1%**	3.57
2012	5,990	0.4%	14,103	0.9%	**20,093**	1.3%	**53,392**	0.37%	**37.6%**	3.51
2013	21,912	1.3%	20,633	1.2%	**42,545**	2.5%	**96,602**	0.62%	**44.0%**	4.03
2014	29,536	1.6%	29,935	1.6%	**59,471**	3.2%	**118,682**	0.71%	**50.1%**	4.51
Total	**63,040**	n.a.	**66,430**	n.a.	**129,470**	n.a.	**286,842**	n.a.	**45.1%**	n.a.

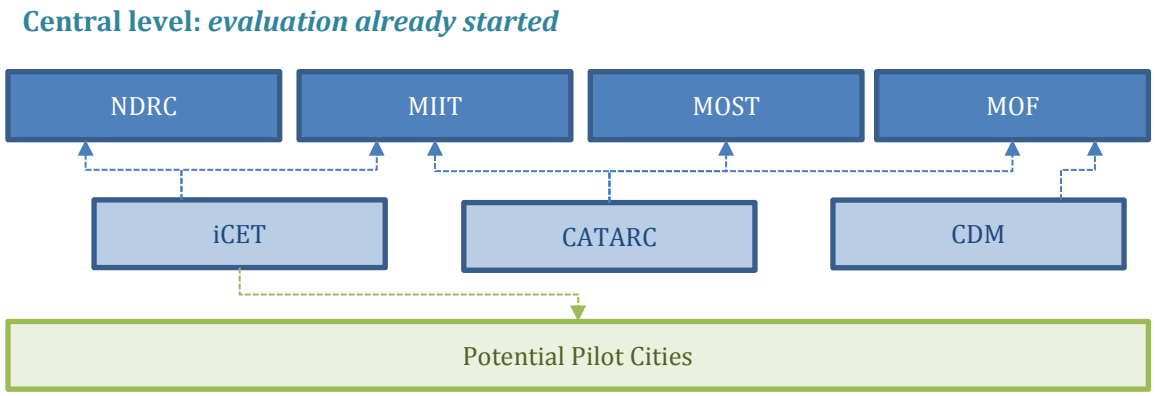
Notes: (1) Market share of total new car registrations in California. **(2)** U.S. market share of total nationwide sales. **(3)** California's market share of total nationwide registrations.

To date, the ZEV credits program has proven to deliver ground-breaking results: no manufacturer selling vehicles in California has breached the regulation in its 7 years of implementation. The ZEV program's early focus on extremely low emitting conventional gasoline vehicles, and non-plug-in hybrids such as the Toyota Prius, has resulted in nearly 2 million Californians driving partial zero and advanced technology partial zero emission vehicles (PZEV and AT PZEV), that have 80% cleaner exhaust than the average 2002 model year car.

The fleet of plug-in electric vehicles in California is also the largest in any country in the world, and accounts for about 40% of the total US PHEV fleet. A total of 129,470 plug-in electric vehicles have been registered in California between December 2010 and December 2014, representing about 45% of all plug-in cars sold in the U.S. During 2014, PEV market share reached 3.2% of total new car sales in the California, up from 2.5% in 2013 and 2.4 percentage points higher than the US new sales for PEVs in 2014[2]. Registrations of plug-in electric cars in the state in 2014 represented 50.1% of total PEV sales in the U.S. that year[3]. Innovative energy vehicle manufacturers new to the industry were able to survive their initial

[1] http://en.wikipedia.org/wiki/Plug-in_electric_vehicles_in_the_United_States#California
[2] Jeff Cobb (2015-03-18). "Californians Bought More Plug-in Cars Than China Last Year". *HybridCars.com*. Retrieved 2015-04-18.
[3] http://www.cncda.org/CMS/Pubs/Cal_Covering_4Q_14.pdf

years arguably by the demand and external profit enabled by the regulation, a phenomenon that did not occur anywhere else. This phenomenon has been extensively studied in *i*CET's recent reports[4].



The ZEV-credits program has been identified as a key project with high contribution value to support sub-national low-emission development in China. The program has recently received the attention of national decision-makers (including NDRC, MOF, MIIT) as well as local planners (mainly local DRCs and Transport Commissions). On the national front, the central government has recently called for the integration of market tools in support of its fuel consumption reduction efforts. The Ministry of Finance invited the national CDM Fund (a governmental fund dedicated to support low-carbon development) to introduce the ZEV program and CATARC has started the discussion of a national ZEV program and has recently explored potential pilot cities. Both CDM Fund and CATARC invited *i*CET to contribute to their ZEV credits study. Several municipal Development and Reform Commissions (DRCs) have called for regulatory recommendations that would advance new-energy vehicles adoption and spur related local innovation, beyond existing regulatory requirements. Shenzhen, for example, is set to roll-out the integration of transport carbon emissions in its pilot emissions trading system starting 2015 and has invited *i*CET to introduce the California ZEV program and its localization potential. Other cities have also asked *i*CET to introduce its ZEV work, including Beijing and Shanghai.

A concern over national support of a Chinese program stems from thoughts expressed by experts throughout the first quarter of 2015. Experts suggested that since MIIT is advocating for corporate average fuel consumption credits trading as a flexible pathway to meet its Phase IV fuel economy standard, any other trading mechanism occurring at the same period may erode the effects of this new flexibility mechanism and therefore would find opposition at the ministerial level. Policy packaging and credits exchange are pathways that the US have pursued for accelerating air quality improvements, therefore concerns over a single policy impact assessment could be eased should adequate policy management be put in place.

[4] http://www.icet.org.cn/reports.asp?fid=20&mid=21

Contents

Terms

AFV: Alternative fuel vehicle

ATV: Advanced technology vehicles

EV: Electric vehicle

FCV: Fuel-Cell Vehicle

HEV: Hybrid electric vehicle

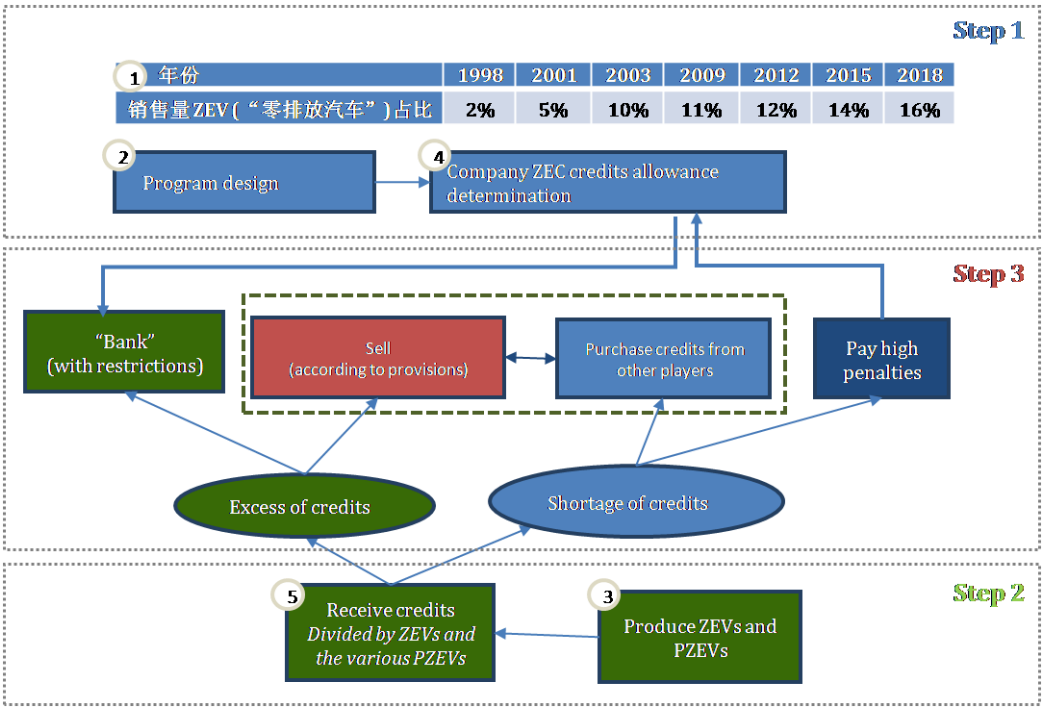
PEV: Plug-in electric vehicle

PHEV: Plug-in hybrid electric vehicle

ZEV: Zero emission vehicle

The ZEV Credits Program in a Nutshell

Step 1: Local governments set a long-term and *gradually increasing* mandate of *% NEV sales* requirement for each *large* (>10,000 sales volume) *company's* local *car sales* [In the figure on the left: 1->2->3->4->5]



Step 2: All car companies *develop and produce NEVs* in order to meet the target, and *supply chain* and *infrastructure* benefits from the increase in demand for EV parts [In the figure on the left: 1->2->3->4->5]

Step 3: By year-end, companies submit proof of sales and receive ZEV credits accordingly; companies not meeting the ZEV credits requirement can either: (i) pay a heavy penalty ($5k for Type 0 credit not delivered in CA) or (ii) *buy credits* from companies with excess credits (through internal negotiations, government-set penalty is the “ceiling value”). Companies meeting the credits requirement: (i) *sell credits* to other companies or (ii) *“bank” credits* for future years (to get better deals or prepare for mandate stringency increase). Annual and accumulated volumes of credits are published on the government's website.

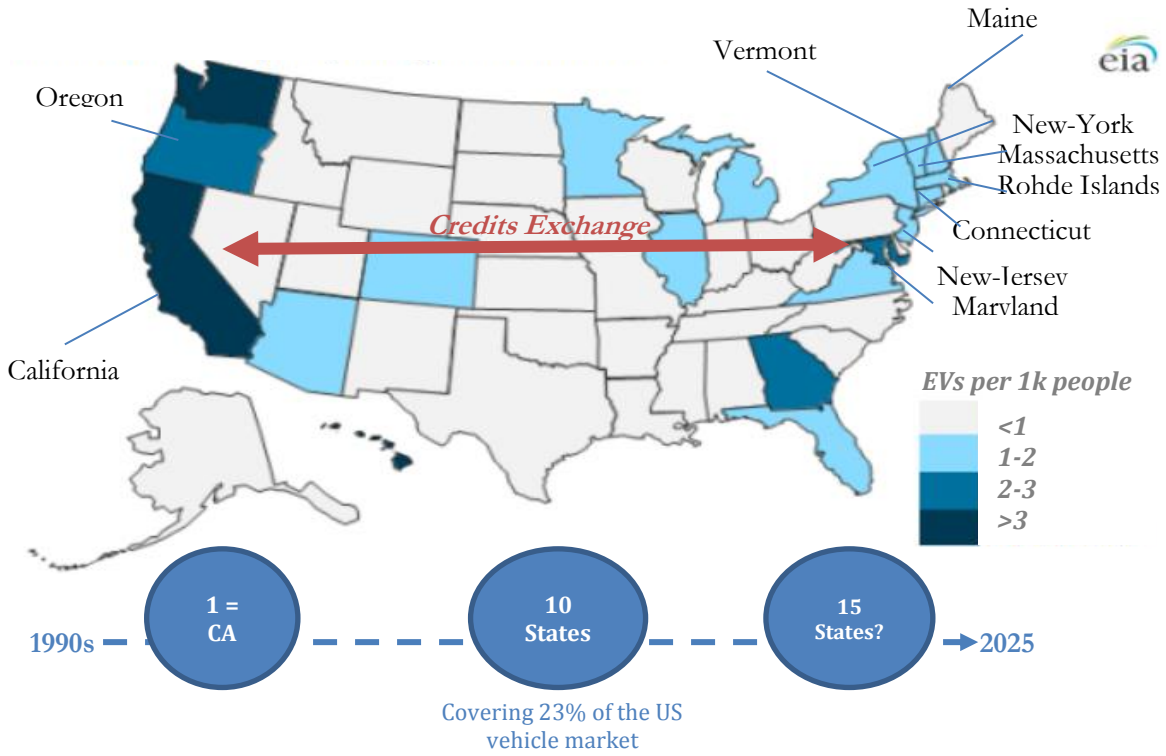
Design Inputs: Q&A

Q1: Should a China ZEV-Credit program be developed nationally or locally?

In the case of California, clearly a state level program was the first step and was given authorization from the federal government. Four years into its implementation, 9 more states established a similar program in consultation with California and the support of the federal government (e.g. federal tax and

funds). The states have a credits exchange agreement, making the program a semi-national one. Under the assumption that the greater the market, the greater the impact and value, more states are expected to join the program. Furthermore, states have been collaborating with the California government on complementary initiatives, most predominantly "The Multi-State ZEV Action Plan" signed in October 2013 by 8 states, constituting 23.6% of US vehicle 2012 vehicle sales. This relatively new initiative set a deployment target of 3.3 million ZEVs (approximately 15% of projected new car sales in 2025[5]) and adequate fuelling infrastructure by 2025. The power of several states in promoting emerging industry development and deployment seems to be crucial for the case of ZEVs for two main reasons: infrastructure should be continuous to enable unlimited driving distances as much as possible; and equipment (fueling/charging and powertrain) should be standardized to be as united as possible[6].

ZEV mandate expansion in the US, and EV by-state relative uptake*



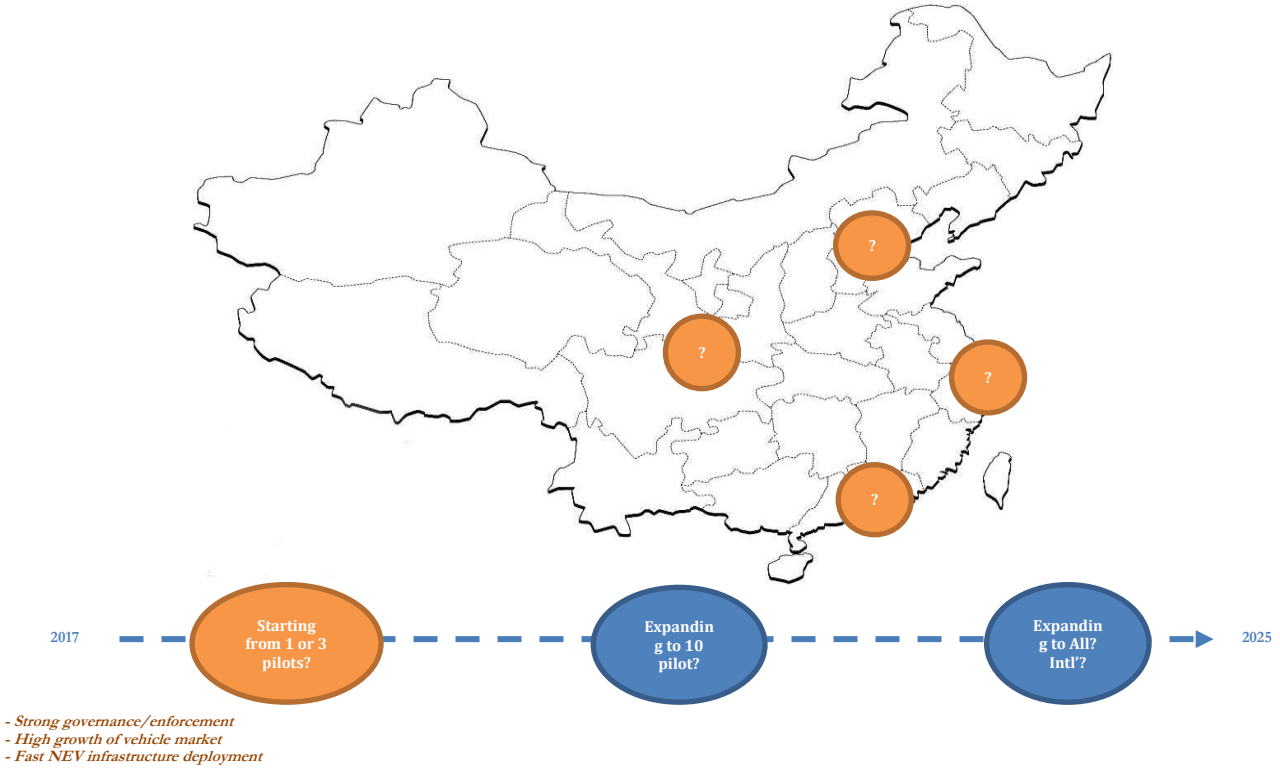
[5] Carson, E., & Davis, E. (July 2014). *Multi-State ZEV Action Plan: driving the Zero-Emission Vehicle Market Forward.* ENERKNOL, p. 2.

[6] All electric cars in the USA can use the standard 240 volt charger (Level 2) that can typical recharge a vehicle in 4 hours, depending on battery size. However, for DC fast charging (typically 80% charge in 20 to 30 minutes), there are currently different types of charge ports used on vehicles that require a matching charge connector at a station., For example, to date for fast charging, Nissan Leaf drivers can only use CHAdeMO standard stations, BMW i3 and Chevrolet Spark EV can only use SAE Combo stations, while Tesla vehicles have a different charge port which is compatible with its proprietary Supercharger network. These players account for about 80% of the US EV market. Some auto manufacturers such as Tesla have adapters that enable their vehicles to charge on a wider variety of standards (e.g. CHAdeMO), and this trend is expected to grow as standardization evolves.

** Not only states with relatively high EV sales volumes such as Oregon, New-Jersey and Maryland joined, but also states with insignificant EV sales rates such as Maine adopted the ZEV credits mandate. This demonstrates that supply of credits is not a concern at the second wave of mandate adoption (thanks to credits trading) and that adoption states seek to accelerate local EV consumer and industry uptake through the mandate.*

China's policy makers have recently realized the unique potential benefits of ZEV adoption in China, however since cross-ministerial consent is required as well as sound proof of a well-working pilot, it is probable that cities would advance actual ZEV-credits implementation in China. As each Chinese city has its own unique characteristics and constraints, different design recommendations would apply to different cities. Furthermore, local governments take pride in novel ideas, therefore, local adoption is best motivated through tailored support.

Potential ZEV mandate geographical development in China



Q2: What is the ideal process of a China ZEV credits system design?

In the case of California, *CARB directed the execution of comprehensive in-depth technology studies by prominent experts* in order to inform the state's 1994 announced "road map" for attaining clean air standards (the State Implementation Plan, SIP) and the zero-tailpipe emissions technology forcing regulation. The first inclusion of ZEV-credits, in the first Low Emission Vehicle (LEV) regulation, which was enforced from 1994 through 2003, was as a footnote: "While meeting the fleet average standards, each manufacturer's sales fleet shall be composed of at least 2% ZEVs in the model years 1998 through 2000, 5% ZEVs in 2001 and 2002, and 10% ZEVs in 2003 and subsequent."

Since its original adoption, the ZEV regulation *has been adjusted six times* (in 1996, 1998, 2001, 2003, 2008, and 2012) *in consultation with, arguably, all related stakeholders* to reflect the pace of ZEV development and the emergence of new ZEV and ZEV-like technologies. CARB has committed itself to biennial evaluations of the state of technology, based on which it revised the time frame of the ZEV mandate and the vehicle technologies it included. For example, a Battery Technology Advisory Panel (BTAP) was convened to assess the state of battery technology development, and concluded in 1995 that battery achievement was projected to lag behind the mandate by three years. Hence, the ZEV requirement was pushed ahead and vehicles that would deliver similar immediate environmental improvements (PZEVs) were phased in. A snapshot of the mandate vehicle types and their commercialization timeline is offered in the below table.

ZEV mandate phase in and commercial uptake

Phase I: Mandate kick-off →	Phase II: Studies of Implementation Progress →	Phase III: Implementation
ZEV regulation adopted in 1990 following consultation with govt' & industry stakeholders **Lead time for technology and market development provided**	▪ Experts conducted ~3 year in-depth studies of ZEV technology development in several countries and at leading vehicle manufacturers. ▪ Biennial studies thereafter for keeping track of technology improvements.	▪ Assessments of early program progress, including compliance. ▪ Adjustments to design and future standards following stakeholders' consultations.

In the case of China, given its potential access to global vehicle technologies and its intrinsic innovation capacity, international technology roadmaps may suffice the design of a China-tailored mandate. By skipping the long and highly exhaustive technology mapping process, China can design its own ZEV mandate rather rapidly by relying on existing knowledge and through consultation with global and national experts. Similar to other innovative policies such as the ETS, the ZEV-credits program can be developed in the following fashion: (1) an official expression of interest and call for engagement in the design process; (2) a mandate design process comprised of a standard, regulatory structure and mandate design and enforcement. The design process will primarily take into account local NEV manufacturing and deployment goals, regulatory management barriers, as well as short and long term economic impacts; (3) Assessment of

the success of initial implementation and development of recommendations for advising its future design and scaling.

Suggested China ZEV mandate design process, for discussion:

Phase I: Mandate kick-off →	Phase II: Mandate design →	Phase III: Implementation
▪ ZEV program plan published ▪ Engage govt' & industry stakeholders*	▪ Standards design (basis of the mandate) ▪ Mandate regulatory structure design ▪ Mandate design	▪ Initial period phase-in ▪ Second period design

** Stakeholders' engagement should occur prior to the mandate kick-off*

Q3: Who should be involved in a China ZEV credits design process?

In the case of California, the (1) federal government has had a crucial role in enabling the ZEV mandate:

1.1 It has given the state of *California the permission to set up regulations* that go beyond the federal regulation in stringency and boldness (since the Air Quality Act of 1967, which is maintained in the current Clean Air Act). Cutting-edge governing methods as well as regulatory design could therefore be tested in the case of one state before scaling to other states.

1.2 It used *federal funds* to inspire policy innovation and attaining goals: In the late 1980's, California found itself at risk of losing federal funds for the construction of transportation infrastructure if the state did not show progress towards air quality attainment[7]. The California Air Resource Board (CARB), faced with severe air quality issues, developed its initial ZEV requirement within its broader first Low Emissions Vehicle (LEV I) regulation in the 1990s.

1.3 *State-directed collaborative efforts to bring players together* have developed alongside the ZEV mandate for supporting its goals. Although the majority of government initiated partnerships did not result in direct commercial solutions, they have facilitated more open and direct communication and enabled testing and evaluating vehicle technologies in a cost-effective manner, e.g.: In 1990, the US Advanced Battery Consortium (USABC) was formed for developing advanced electric batteries through joint

[7] Collantes, G., & Sperling, D. (2008). The origin of California's zero emission vehicle mandate. *Transportation Research Part A 42*, p. 1304.

research work between government agencies and industry players; In 1993, the Partnership for the New Generation Vehicles (PNGV) was initiated; In 2000, the California Fuel Cell Partnership was created, followed by the California Plug-in Vehicle Collaborative.

(2) Local government had goals beyond sparking the concept of the ZEV regulation:

2.1 Local government's *independent support of demonstration projects*. For instance, the L.A. Initiative received government support (the Los Angeles Department of Water and Power) as well as private support (which in many cases is encouraged by the government support) for the deployment of 10,000 EVs by 1995. Although only a few auto manufacturers responded to the challenge and the project delivered only prototypes, it has enabled knowledge attainment and proof of concept. Demonstration projects by themselves cannot deliver commercialization, yet are instrumental for bringing stakeholders together, directing industry efforts to a similar direction.

2.2 Funding studies for informing the potential for implementation and market impacts of the regulation (CARB and the University of California Davis have worked closely to develop expertise to study and evaluate the market conditions for expanding the number of ZEVs, and the complementary policies needed such as charging infrastructure).

2.3 Maintaining a governing role with adequate experts and management structure (described in the below Q&A).

(3) The development of the California ZEV-Credits program has proven industry reluctances to commercializing cutting edge vehicle technologies. In a workshop organized by CARB to introduce the regulatory concept[8], most automakers expressed opposition. However, policymakers, accustomed to industry reluctance to bring progress, have aimed at one large industry supporter for pushing their regulation forward. The industry's role has become clearer throughout the rollout of the regulation. *Industry cooperation with policy-makers on studying technological readiness and projections* is instrumental for bringing impactful results. Interestingly, the case of Tesla has showcased that large players are not always well-positioned to deliver disruptive innovation as small and independent new players. Although regulations depend on large players willingness to cooperate, small players fighting for their existence may be well suited for informing advanced regulations.

(4) Third-party players have also played a role in the California ZEV mandate creation and re-affirmation throughout the years, mainly in reaction to strong industry players' opposition:

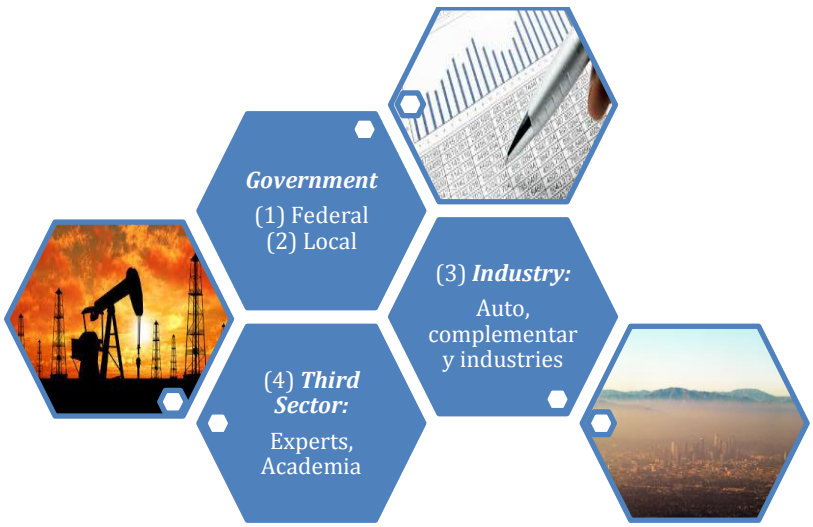
[8] At the time the ZEV-Credits program was introduced, the rule fully applied to companies with annual sales of over 60,000 vehicles in California, applying to Chrysler, Ford, General Motors, Honda, Mazda, Nissan and Toyota.

4.1 The socio-political context that has steered the ZEV credits program development and approval includes third party sector players. In the late 1980's, the Natural Resources Defense Council (NRDC) won an appeal in court which changed the US Environmental Protection Agency (EPA) methodology for determining safety levels of toxic pollutants: instead of using considerations of cost to industry, EPA should use health considerations. This fundamental change in regulatory design is considered revolutionary and set the stage for more aggressive governing frameworks forcing environmental improvements despite the heavy costs to industry. In another case, brought to court by the Coalition for Clean Air and the Sierra Club, EPA was instructed to address the failure of the South Coast Air Quality Management District to attain air quality standards by providing a clean action plan.

4.2 *Academic and research institutions inspire and test innovative solutions, map stakeholders' engagements and have the capacity to bring together different players for addressing a mutual goal*. Credible information and data gathering can inform more comprehensive and forward looking governance as well as industry strategies, including energy storage and efficiency solutions, alternative electricity and off-peak charging incentives.

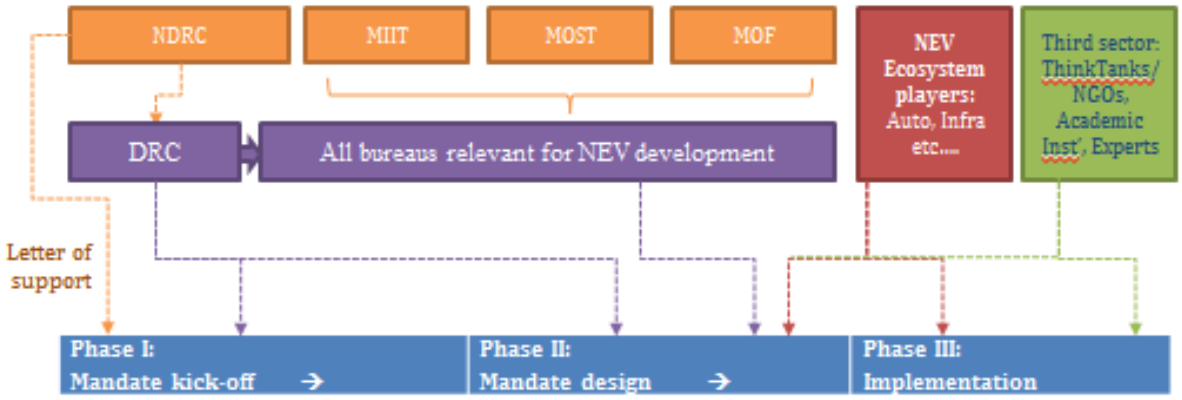
4.3 P*ublic opinion shapers, which can also be referred to as a type of third-party player, are also of pivotal importance to increase ZEV demand and alternate the vehicle market*. For example, in the recent Multi-State ZEV Plan, car dealerships are addressed as part of a larger effort to inform consumers of the merits of ZEVs. Further initiatives to inform sustainable consumption and adjust consumers to the notion of a new type of private mobility are typically left to the hands of the third sector. *i*CET, for example, has been reflecting on the GHG footprint of private vehicle choices in China through its China Green Car system since 2006. Such efforts, however, are toothless without the support of strong government and opinion shapers.

California's multi-stakeholders engagement in the ZEV credits mandate design



China's policy ecosystem is typically comprised of a top-down organizational governance structure and weak implementation management capacities. Recent flexibility-mechanism design efforts and EV stakeholders' engagement initiatives indicate that receptiveness of new inclusive policy-making processes exist. Therefore a design process in which all sectors have a role may be as relevant for China as it was for California.

Suggested stakeholder engagement in a China ZEV design process, for discussion:



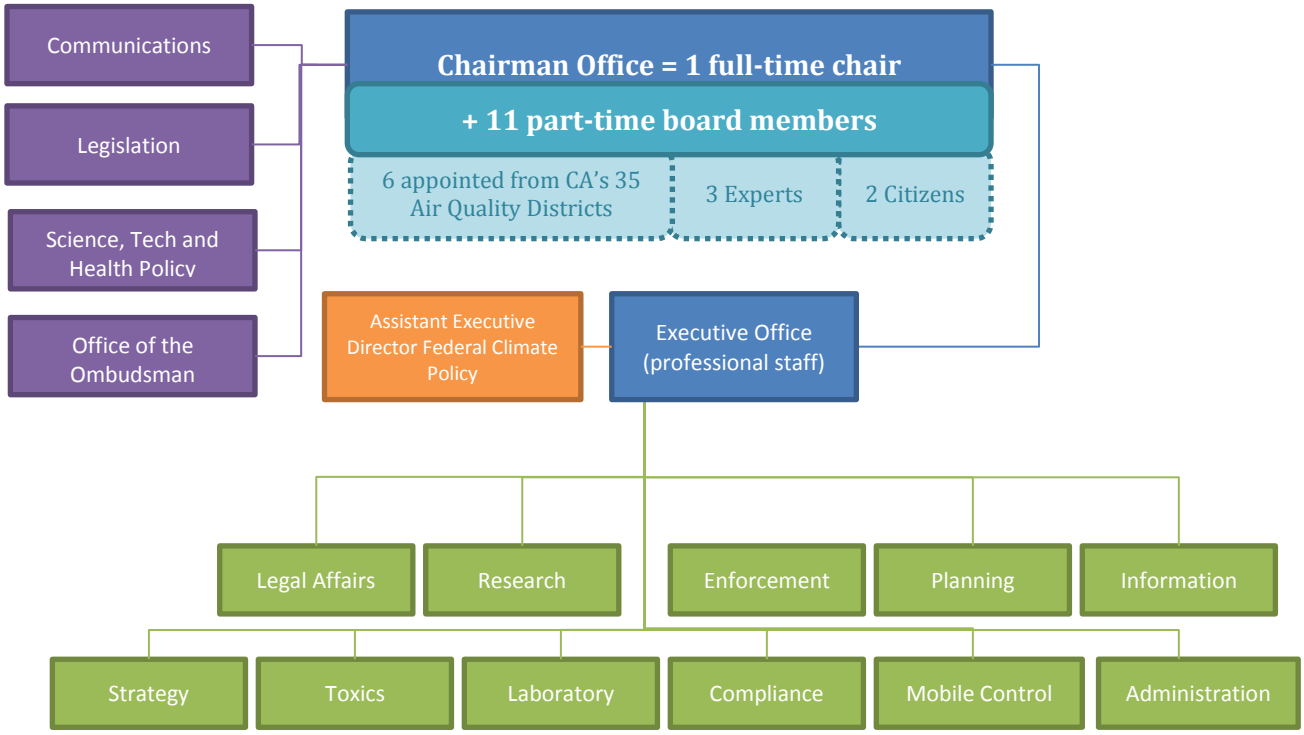
Q4: Who should be governing a China ZEV credits program?

In the case of the California Air Resources Board (CARB[9]), an agency of the California government, its independent structure has been crucial for the ability to pass the regulation and support its implementation throughout the years. CARB is headed by a board of a full-time chairman and 11 part-time members, which include six appointed from California's 35 air quality districts, three expert members (public health, automotive engineering, science and agriculture or law), and two unspecified citizens. The board oversees some 1000 staffers with technical expertise, and in the case of the ZEV mandate, it required staff to prepare biennial reviews to assess the technology advancement and capacity to meet the standard requirements in due course[10]. All decisions are made through public monthly board meetings, and any stakeholder contact must be disclosed before each vote, ensuring professionalism and transparency, suppressing political attempts to influence decisions. The Achilles heel of CARB's structure is in the

[9] CARB was formed in the late 1960s by combining the California Motor Vehicle Pollution board and the Bureau of Air Sanitation.
[10] Public Policy Institute of California. (2007). Learning from California's Zero-Emission Vehicle Program. *California Economic Policy*, Vol 3(4), p. 6.

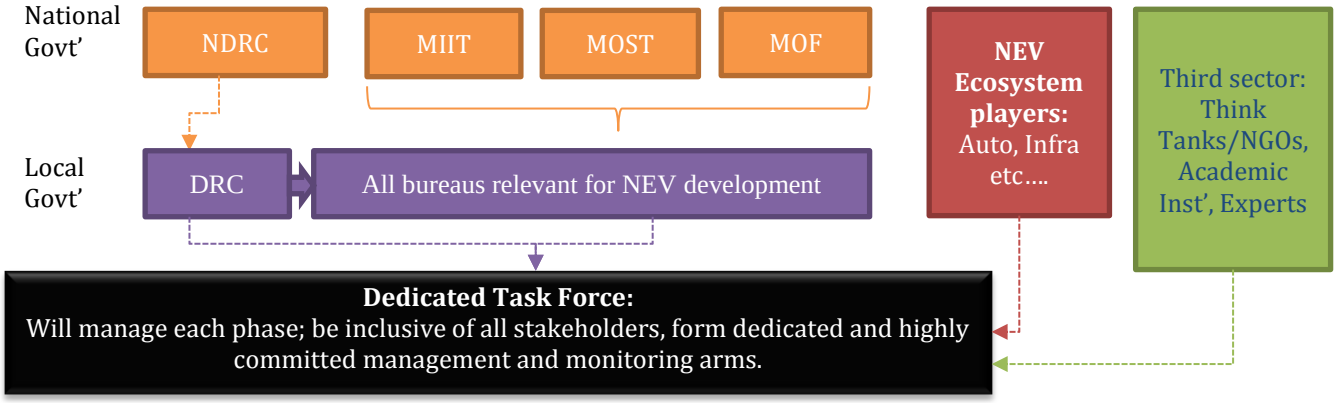
governor's ability to appoint and dismiss board members at any time, and the legislature ability to influence the agency's annual budget. However, no abuse of these breaches has been noted to date. The governing body over the ZEV mandate, the board, is comprised of air quality experts and doesn't include any auto makers. Auto manufacturers have been consulted with during the design stage and are constantly corresponding with the board in regards to policy modifications (often cases seeking to ease the requirement, naturally).

California Air Resources Board Organization: Governing ZEV credits



In the case of China, given its existing multi-ministerial responsibilities in governing NEV development and the complex vehicle regulatory landscape in general, a much more simple governing entity could take shape for ensuring simplicity and representation. It is worthwhile to consider assigning a dedicated task force that would employ credibility-forming approaches similar to those of California, such as experts' periodic reviews and open communication channels.

Suggested China ZEV design governance, for discussion:



Q5: What is the target or desired impact of a China-tailored ZEV credits program?

The original rationale behind the California ZEV credits requirement was that (i) the projected improvements in conventional vehicle technology (largely required by the Low Emissions Vehicle regulation) were not and will not be sufficient to meet air quality standards, and that (ii) ZEVs can avoid the internal combustion engine vehicle emissions' performance deterioration with age. This remains true today. The more recent challenges of climate change have also shown that the ZEV mandate is an essential tool to reduce GHG emissions.

As California has been leading the standards of regulating emissions from mobile sources since the late 1960s, and has been driving federal GHG emissions standards since the 2000s, the task of isolating the influences of the ZEV mandate from the enhanced LEV (I and II) regulatory outcomes is a challenging one. Yet the targets for ZEV have recently been re-announced and the impacts of the California ZEV regulation can be illustrated through market uptake of EVs and the local industry positioning as global leader. With the target of advancing sales to 1/7 cars (15.4% of projected sales estimated at 1.4M) of non- or nearly-nonpolluting vehicles[11] and achieving a significant reduction in GHG emissions by 2025[12], California is aiming to achieve the following goals**:**

- New vehicles will emit 34% fewer GHGs and 75% fewer smog-forming emissions by 2025, therefore addressing both global and local challenges.
- Environmentally superior cars will be available across the range of models (compacts, SUVs, pickups, minivans etc.), thus avoiding consumer compromise while shifting to greener vehicles.
- Consumer savings on fuel costs will average $6,000 over the life of the car. The savings are projected to be greater than the average $1,900 increase in vehicle price for ultra-clean, high-efficiency technology. Based on developments today and studies released by the National Academies of Science,

[11] PHEV, EV and Hydrogen Fuel-cell vehicles.
[12] Large volume manufacturers selling at least 20k vehicles in California, would have to introduce Zero Emissions Vehicles that would account for at least 15.4% of their fleets.

the cost of both BEVs and FCEV should reach parity with advance conventional gasoline cars by the 2030s.

- Market conditions which independently promote the adoption of cleaner private transportation would hence be put in place allowing for mass adoption beyond the limited early-adoption in the future. An immediate market supporting outcomes lay in the fact that currently the number of ZEVs is low enough that sales of larger volume conventional cars can absorb the higher cost of ZEVs, given that the government is providing between $7,500 and $10,000 purchase incentives, fueling infrastructure and preferential treatment such as access to car pool lanes and reduced parking costs.

Since the 1990s, CARB continues to refine its definition of vehicles by their relative volume of emissions, making sure technological progress is constantly being incentivized towards an end-goal of zero-emissions vehicles. The current general definitions are as follows:

California Vehicle Groups Introduction

Vehicle group acronym	Definition
LEV(Low Emission Vehicle)	The least stringent emission standard for all new cars sold in California beyond 2004.
ULEV(Ultra Low Emission Vehicle)	50% cleaner than the average new 2003 model vehicle.
SULEV(Super Ultra Low Emission Vehicle)	These vehicles emit substantially lower levels of hydrocarbons, carbon monoxide, oxides of nitrogen and particulate matter than conventional vehicles. They are 90% cleaner than the average new 2003 model vehicle.
PZEV (Partial Zero Emission Vehicle)	Meets SULEV tailpipe standards, has a 15-year / 150,000 mile warranty, and zero evaporative emissions. These vehicles are 80% cleaner than the average 2002 model car.
AT PZEV (Advanced Technology PZEV)	These are advanced technology vehicles that meet PZEV standards and include ZEV enabling technology. They are 80% cleaner than the average 2002 model car.
ZEV (Zero Emission Vehicle)	Zero tailpipe emissions, and 98% cleaner than the average new 2003 model vehicle.
TZEV (Transitional Zero Emissions Vehicles)	Transitional zero emission vehicles (TZEVs) are vehicles with zero emission capability of at least 10 miles, and that meet **ultra-low tailpipe emission standards,** *e.g. PHEV.* The name was changed during the 2012 ZEV amendments from Enhanced AT PZEVs to TZEVs for simplicity.

California has arguably enabled the following achievements through the ZEV credits mandate:

- California is home to 48% of US electric cars.
- More than 2 million Californians are driving partial zero and advanced technology partial zero emission vehicles (extremely low emitting conventional gasoline vehicles, and non-plug-in hybrids such as the Toyota Prius), with near-zero tailpipe emissions and some 80% cleaner exhausts than the average 2002 model year car.
- 15 folds increase in annual EV patents registration since the regulation announced, global leader.
- 9 more states have already adopted the regulation, extending the market to 23% of US car sales.

- Multiple industry collaboration R&D and extensive EV supply chain development as a complementary market inspired many hybrid models and other clean vehicle technologies investments.
- Innovative energy vehicle manufacturers new to the industry were able to survive their initial years arguably by the demand and external profit enabled by the regulation (e.g. Tesla Motors).

In China, the ZEV regulation can serve both the existing ambitious national and local NEV 2020 targets and local air quality improvement goals. Here are some possible guidelines:

- The China ZEV can **fit other national regulations**, ultimately aiming at accelerating NEV commercial production.
- **Define NEV to include EV/FCV + PHEV**, where EV/FCV is favorable to PHEV.
- **Based on LOCAL sales** under best-case (perhaps could also be based on production, although production isn't directly linked to local air quality).
- Can be **measured by curbed emission levels** (e.g. unit measurement could be CO2, or a normalized figure based on selected emission factors).
- Include ultra-low emission vehicles with advanced technologies, namely ATV, that may eligible for 1 credit at the first phase for increasing credit supply and corporate engagement.

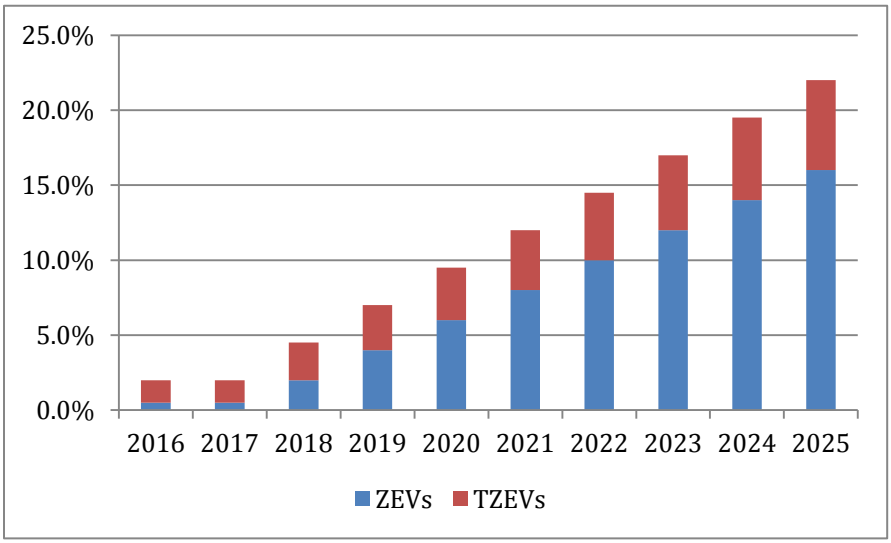
Suggested China ZEV target, for discussion:

NEV =	EV/FCV (6-10 credits) +	PHEV (2 credit) +	ATV (1 credit)
Based on sales, increasing over time (apart from ATV that will fade away as credits supply during phase I is secured)			

Q6: How should the mandate look like?

The California mandate has undergone changes in stringency and flexibility following constant stakeholders' consultation. The boldest revisions were made in 2012, expressing an increase in stringency by recognizing that hybrids have reached market maturity and thus should no longer be stimulated through the ZEV credits program. In conjunction with the GHG2 standard adopted in January that year, the ZEV requirements were raised to 15.4% of sales by 2025 and the concept of Transitional ZEVs replaced the previously known Enhanced Advanced PZEV, highlighting the value of zero-emissions tail-pipe and electricity/hydrogen fuel. The below figures illustrated the gradual increase in minimum ZEV floor which is the heart of the ZEV credits program mandate.

California Vehicle Groups Introduction



纯零排放汽车 e.g. BEV, BEVx, FCV.	近零排放汽车 e.g. PHEV, HICE.

In China, the ZEV mandate design should serve the target in an implementable, simple and measurable manner. The goal is to increase the amount of zero or near zero tailpipe emissions vehicles over the years while "pushing" the clean vehicle industry to its most innovative edges and defending small manufacturers, which are financially sensitive. The annual target should fit market feasibility rather than market convenience. Here are some suggestions for the method to determine annual targets:

- According to the state of the NEV market and its projected evolvement, set **different numbers of credits for different NEV types**;
- **Reward very advanced technologies (PEV/FCV)** with more credits to cover for their cost of development in the early years, when demand and infrastructure are still weak.
- Make sure the credits value per vehicle type **changes according to the evolving market**, e.g. reduce PHEV credits once enough infrastructure for PEV is in place.

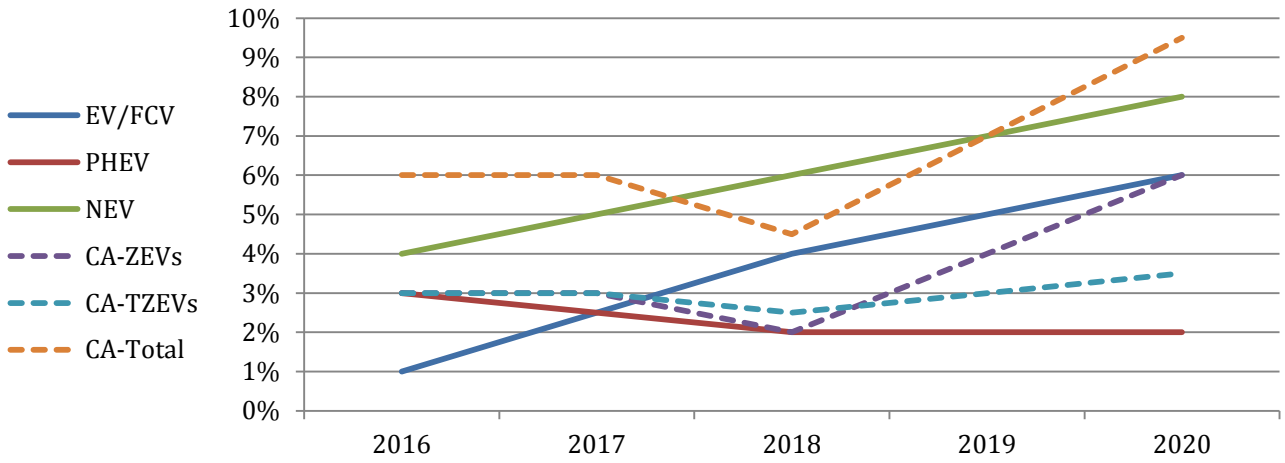
Suggested China ZEV target and subsequent method, for discussion:

NEV =	EV/FCV (6-10 credits) +	PHEV (2 credit) +	ATV (1 credit)*
Based on sales, increasing over time (apart from ATV that will fade away as credits supply during phase I is secured*)			

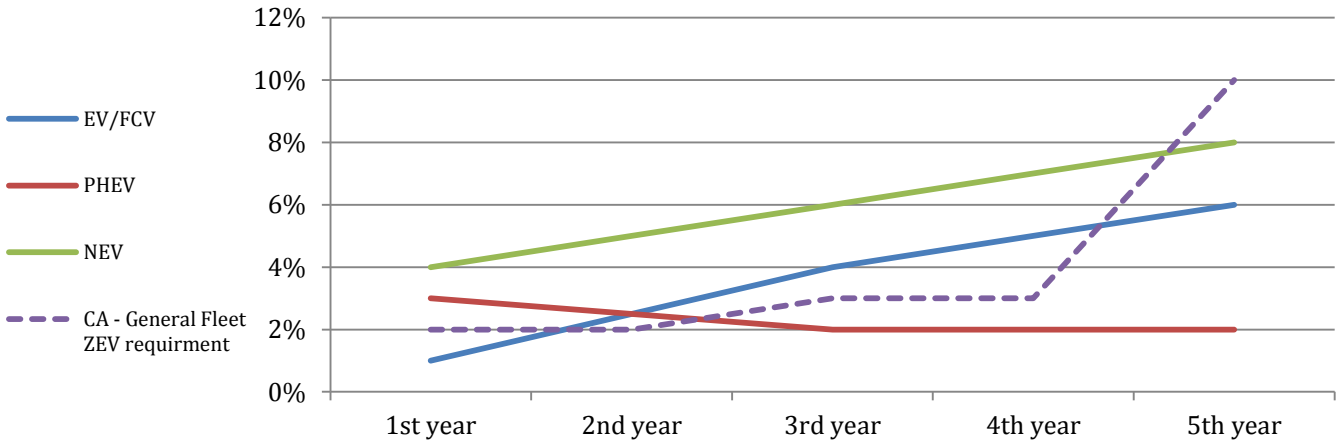
	2016	2017	2018	2019	2020
EV/FCV	1%	2.5%	4%	5%	6%
PHEV	3%	2.5%	2%	2%	2%
NEV	4%	5%	6%	7%	8%

** ATVs could generate a lot of credits fast and undercut the ZEV production for quite some time, therefore should be carefully designed and be disregarded in a relatively short timeframe.*

Suggested China ZEV target vs. California's target for the same period:



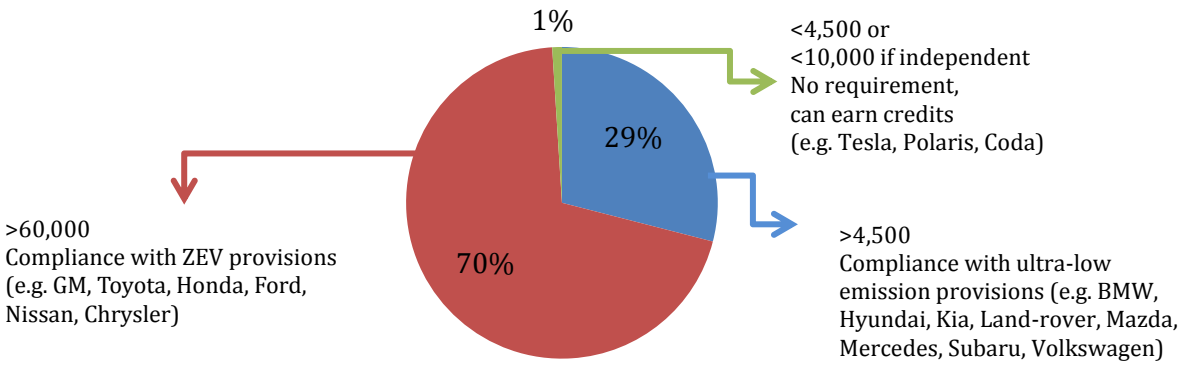
Suggested China ZEV target vs. California's:



Q7: Who should carry the burden of compliance and who should be exempt?

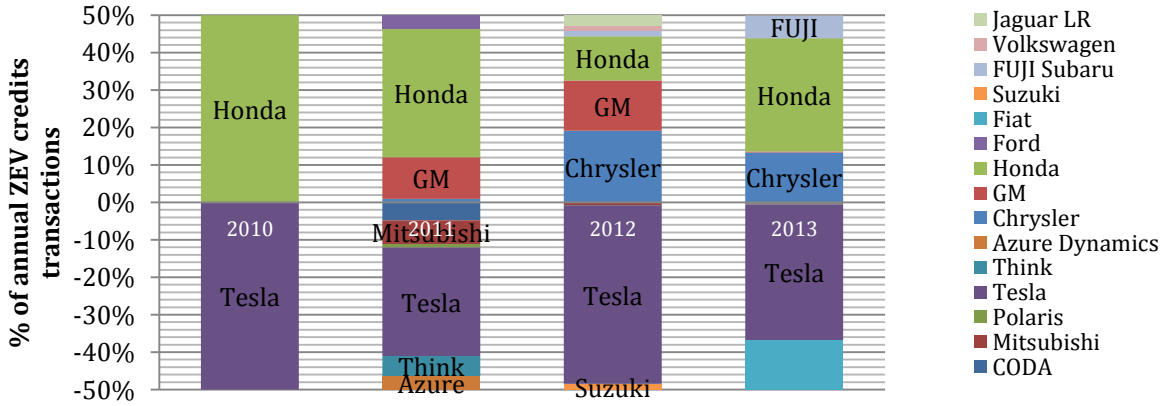
In California, the annual target is gradually being increased towards the target and the PEV component of the ZEV target increases as well. Companies that must comply are those with most vehicle sales while small manufacturers can earn credits and sell them to support their growth (e.g. Tesla Motors). Car companies verify compliance with the ZEV mandate after receiving vehicle categorization approval (based of proofs such as tests results) and sales volume confirmation (a vehicle is considered sold after it receives a license plate and is officially "on the road") from the California Air Recourse Board. As a company grows in sales, it has a grace period before it shifts upwards in the mandate category.

California ZEV credits mandate compliance groups: by 3 year average sales*

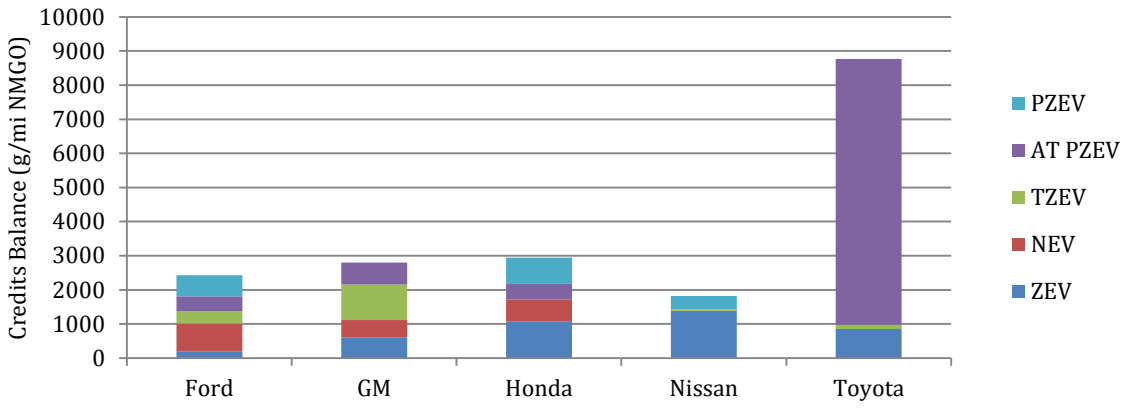


** Compliance from 2018 and beyond required by manufactures selling over 20,000 units per year.*

Major California ZEV credits transaction overtime: from 2010 to 2013



ZEV-credits Balance: 2013 update



In China, there are currently about nine manufacturers[13] that have EV manufacturing experience and are accountable for as much as 48% of all private vehicle sales in China. In 2013, these manufacturers were producing a volume of under 1.55 million vehicles each. Cumulatively, they manufactured 8.35 million ICE vehicles and over 170,000 PHEVs and EVs[14]. The percentage of NEVs has increased significantly in 2014 and early 2015 (to this date). A new regulation[15], for example, is encouraging the establishment of EV companies by easing restrictions should a manufacturer register EV IP in the mainland and exclude non-EV production from its business portfolio. Although the potential volume of ZEV credits based on current production is rather small, it may increase rapidly, equipping leading NEV companies with sufficient back-wind to reach economies of scale from which the industry as a whole will benefit. In order to make sure funding is transferred through credits transactions, the benchmark could consider the following suggestions:

- **Mainly big** and profitable manufacturers **should be required** to meet the mandate.
- **Small and innovative** manufacturers should **only benefit** from production, not be mandated.
- **An ideal threshold of company size would be based on its global sales (e.g. an average of the last 3 years)** rather than production because it represents its financial robustness better, however sales data may be hard to obtain and verify.
- **The ideal credits requirement would be based on local sales figures** in order to represent the

[13] The nine identifies manufacturers with EV capacities are: BYD, BAIC Motors, JAC, Chery, Shanghai-GM, Shanghai-VW, FAW-VW, SGMW, and Beijing-Hyundai.

[14] http://www.chinanews.com/auto/2015/06-08/7329929.shtml

[15] **《新建纯电动乘用车企业管理规定》2015 年第 27 号**
http://www.miit.gov.cn/n11293472/n11293832/n12843926/n13917042/16622703.html

link between its obligations and local air quality targets; however since sales figures may be hard to obtain manufacturing or relative market size could be employed instead.

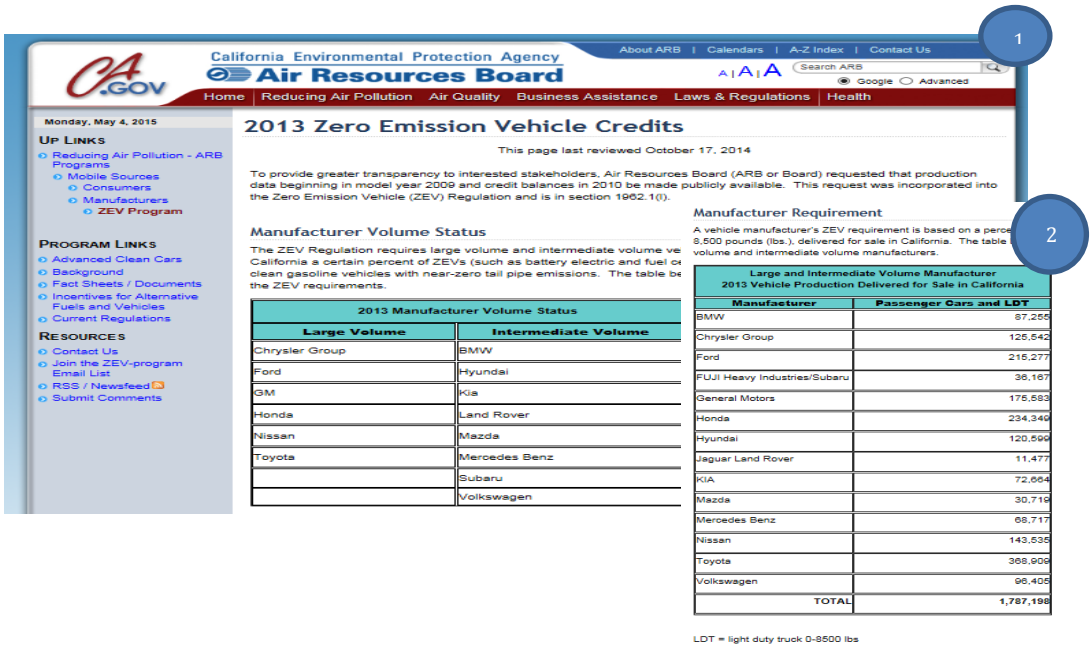
- ***Everyone can earn credits as long as they do not have requirements left to meet!***

Q8: How should the management of the ZEV-Credit system look like?

In California, as stated above, *all decisions are made* in public monthly board meetings, and *any stakeholder contact must be disclosed before each vote*, ensuring professionalism and transparency and suppressing political attempts to influence decisions.

CARB posts each reporting period online soon after the reporting deadline (ranges from September to October). The disclosed information includes: (i) the volume status of participating manufacturers (large or intermediate volume manufacturers), (ii) each manufacturers' sales volume, (iii) each manufacturers total credits balance, and (iv) volume of credits transferred out or in from each manufacturer during the reporting period.

CARB ZEV Credits online information disclosure



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Home | Reducing Air Pollution | Air Quality | Business Assistance | Laws & Regulations | Health

Monday, May 4, 2015

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- Reducing Air Pollution - ARB Programs
  - Mobile Sources
    - Consumers
    - Manufacturers
      - ZEV Program

Program Links
- Advanced Clean Cars
- Background
- Fact Sheets / Documents
- Incentives for Alternative Fuels and Vehicles
- Current Regulations

Resources
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2013 Zero Emission Vehicle Credits

This page last reviewed October 17, 2014

To provide greater transparency to interested stakeholders, Air Resources Board (ARB or Board) requested that production data beginning in model year 2009 and credit balances in 2010 be made publicly available. This request was incorporated into the Zero Emission Vehicle (ZEV) Regulation and is in section 1962.1(i).

Manufacturer Volume Status

The ZEV Regulation requires large volume and intermediate volume ve
California a certain percent of ZEVs (such as battery electric and fuel c
clean gasoline vehicles with near-zero tail pipe emissions. The table be
the ZEV requirements.

2013 Manufacturer Volume Status

Large Volume	Intermediate Volume
Chrysler Group	BMW
Ford	Hyundai
GM	Kia
Honda	Land Rover
Nissan	Mazda
Toyota	Mercedes Benz
	Subaru
	Volkswagen

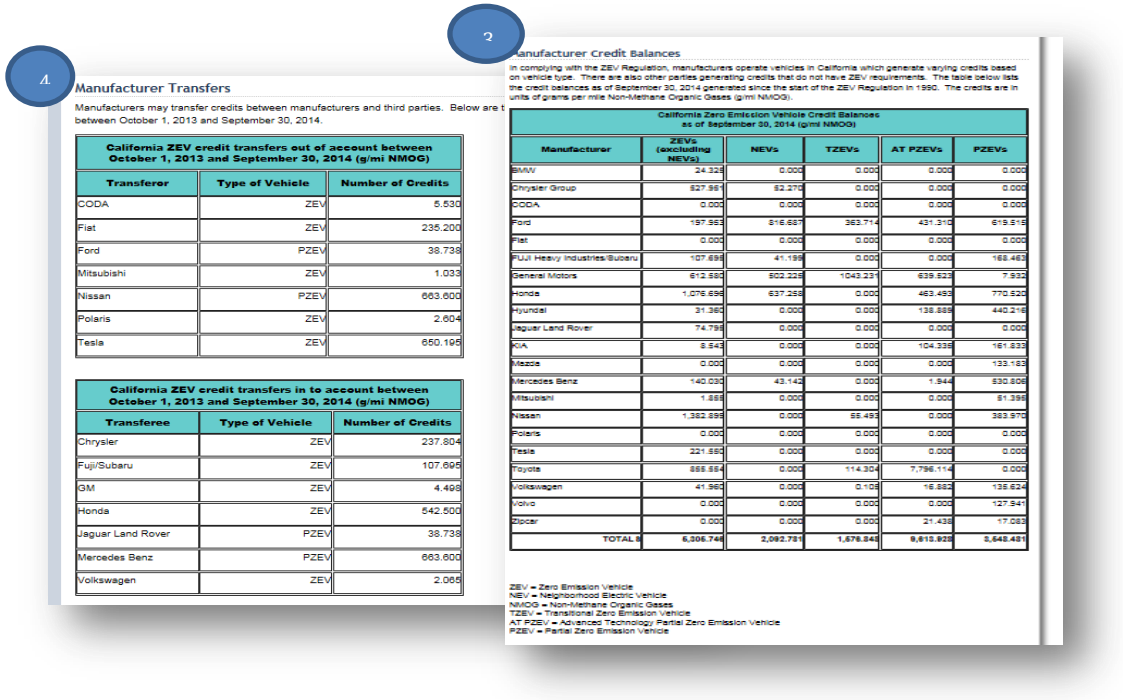
Manufacturer Requirement

A vehicle manufacturer's ZEV requirement is based on a perce
8,500 pounds (lbs.), delivered for sale in California. The table
volume and intermediate volume manufacturers.

Large and Intermediate Volume Manufacturer 2013 Vehicle Production Delivered for Sale in California

Manufacturer	Passenger Cars and LDT
BMW	87,255
Chrysler Group	125,542
Ford	215,277
FUJI Heavy Industries/Subaru	36,167
General Motors	175,583
Honda	234,349
Hyundai	120,599
Jaguar Land Rover	11,477
KIA	72,664
Mazda	30,719
Mercedes Benz	68,717
Nissan	143,536
Toyota	368,909
Volkswagen	96,405
TOTAL	1,787,198

LDT = light duty truck 0-8500 lbs



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Manufacturer Transfers

Manufacturers may transfer credits between manufacturers and third parties. Below are t
between October 1, 2013 and September 30, 2014.

California ZEV credit transfers out of account between October 1, 2013 and September 30, 2014 (g/mi NMOG)		
Transferor	Type of Vehicle	Number of Credits
CODA	ZEV	5.530
Fiat	ZEV	235.200
Ford	PZEV	38.738
Mitsubishi	ZEV	1.033
Nissan	PZEV	663.600
Polaris	ZEV	2.604
Tesla	ZEV	650.195

California ZEV credit transfers in to account between October 1, 2013 and September 30, 2014 (g/mi NMOG)		
Transferee	Type of Vehicle	Number of Credits
Chrysler	ZEV	237.804
Fuji/Subaru	ZEV	107.695
GM	ZEV	4.498
Honda	ZEV	542.500
Jaguar Land Rover	PZEV	38.738
Mercedes Benz	PZEV	663.600
Volkswagen	ZEV	2.065

3

anufacturer Credit Balances

in complying with the ZEV Regulation, manufacturers operate vehicles in California which generate varying credits based on vehicle type. There are also other parties generating credits that do not have ZEV requirements. The table below lists the credit balances as of September 30, 2014 generated since the start of the ZEV Regulation in 1990. The credits are in units of grams per mile Non-Methane Organic Gases (g/mi NMOG).

California Zero Emission Vehicle Credit Balances as of September 30, 2014 (g/mi NMOG)					
Manufacturer	ZEVs (excluding NEVs)	NEVs	TZEVs	AT PZEVs	PZEVs
BMW	24.328	0.000	0.000	0.000	0.000
Chrysler Group	827.961	82.270	0.000	0.000	0.000
CODA	0.000	0.000	0.000	0.000	0.000
Ford	197.953	816.687	363.714	431.310	619.515
Fiat	0.000	0.000	0.000	0.000	0.000
FUJI Heavy Industries/Subaru	107.696	41.199	0.000	0.000	168.463
General Motors	612.580	802.228	1043.234	639.523	7.932
Honda	1,076.656	637.258	0.000	463.493	770.520
Hyundai	31.360	0.000	0.000	138.889	440.216
Jaguar Land Rover	74.798	0.000	0.000	0.000	0.000
KIA	8.543	0.000	0.000	104.338	161.833
Mazda	0.000	0.000	0.000	0.000	133.183
Mercedes Benz	140.030	43.142	0.000	1.944	830.806
Mitsubishi	1.888	0.000	0.000	0.000	81.398
Nissan	1,382.898	0.000	66.493	0.000	383.970
Polaris	0.000	0.000	0.000	0.000	0.000
Tesla	221.593	0.000	0.000	0.000	0.000
Toyota	868.864	0.000	114.304	7,796.114	0.000
Volkswagen	41.960	0.000	0.108	16.882	135.624
Volvo	0.000	0.000	0.000	0.000	127.941
Zipcar	0.000	0.000	0.000	21.438	17.083
TOTAL	6,306.746	2,092.781	1,676.848	9,813.928	3,648.481

ZEV = Zero Emission Vehicle
NEV = Neighborhood Electric Vehicle
NMOG = Non-Methane Organic Gases
TZEV = Transitional Zero Emission Vehicle
AT PZEV = Advanced Technology Partial Zero Emission Vehicle
PZEV = Partial Zero Emission Vehicle

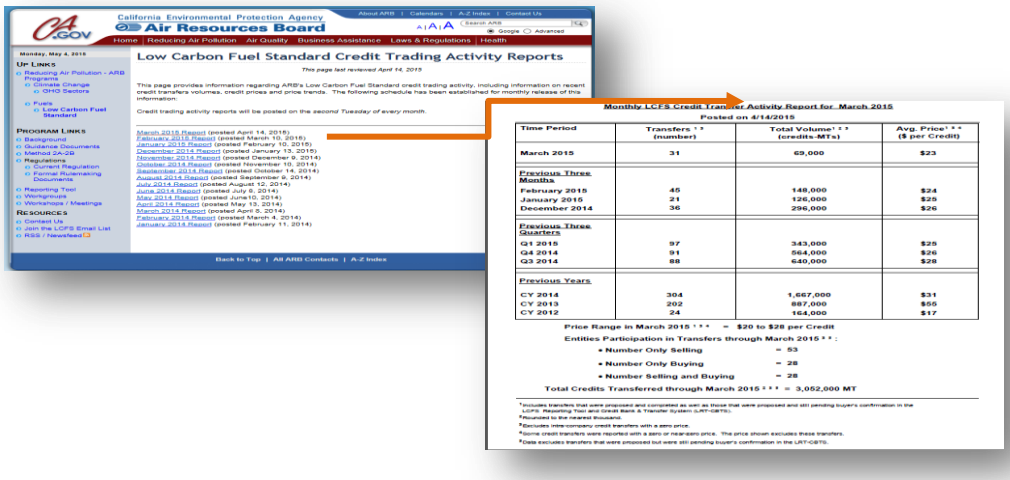
In terms of credits volume management, California historically enabled the acquisition of credits through the sale of ICE vehicles with advanced clean technologies for creating a sufficient credits supply at the mandates' initial years. Credits volume tracking has not been stringent since, and arguably unpredicted raise of independent vehicle manufacturers contributed larger credit volumes at relatively early stages of the mandate. However, the board is in the process of reviewing the issue of oversupply and have recently announced an increased in ZEV requirement (through both the decrease of compliance threshold by 60% from average 3-year sales of 60k to an average of 20k from 2018 onwards, and through the gradual increase of pure ZEV credits requirement per company).

Another crucial element of the ZEV credits management is the *penalty*. If a manufacturer demonstrates non-compliance in its model year-end filings to its CARB officer, it has an additional two years to make up a ZEV deficit. Penalties apply as of the 3rd year. There is a $5,000 penalty per vehicle or credit not produced, under the defined default 1 ZEV credit equivalent value of Type 0 ZEV. For instance, if a vehicle manufacturer is 500 credits short in fulfilling its regulatory requirement, and does not make up the deficit within the following two-year grace period, it will pay a penalty of 500*$5,000=$2.5 million. To date, no manufacturer has chosen the path of penalty; all have transacted credits in order to meet their requirement.

ZEV credit process: close contact between governance and industry

In China, an extensive information online platform could also be adopted, while open communication channels may be more challenging. Unlike California, the online platform may not only indicate previous reporting period transactions but also enable "live" information as for credits transfer in order to proactively encourage trading. Prices of credits are currently not available in California and are negotiated between the parties of a transfer agreement. However should an online platform become available, demand and supply may provide an indication of the value of credits at a given time.

California offers an auction portal for Low Carbon Fuel Standard credits



In terms of the penalty, given its existing legal system, China faces several challenges: there is currently no effective penalty determination and collection mechanism as each geographical jurisdiction is only able to penalize locally registered entities, and penalty determination is a complex process. There are ways around these hurdles: monetary penalties can be replaced with sales caps or other business-curbing methods, local authorities may receive approval to penalize locally active actors even if not locally registered, and penalties could be collected at local sales stores based on sales volumes of inadequate vehicle models beyond the enabled amount. Another method would be to employ current management practices, namely, trust in companies' compliance and shaming of companies (as is done by MIIT for

informing CAFÉ standards compliance). According to "The State Council notice on further strengthening of enterprises fees management for reducing enterprises burden" (Guo Ban Fa [2014] No. 30)[16], the Ministry of Finance in conjunction with relevant departments of the State Council would be able to approve the integration of local enterprises management mechanism with global management mechanisms, in case there is a lack of local management or regulation - this notice provides ZEV-credits mandate with the option of direct linkage to international schemes for enabling more effective management and enforcement mechanism.

In any case, should a nominal penalty be advised, here are some methodological suggestions:

- Penalty should be **higher than the intended market** *price*, to encourage compliance through market credits transactions between market players.
- Penalty should ultimately be **more expensive than production**.
- **Penalties can increase over time**, in order to accelerate compliance and increase the burgeoning power of credits suppliers.
- Works better if there is a **clear payment mechanism and credible enforcement**.

Q9: Should or can a China ZEV-credits program be linked to other programs?

In the case of California, plug-in hybrids must be certified to the SULEV 30 emission standard, which can be found in the low emission vehicle regulation. Also, one provision in the ZEV regulation allows manufacturers to use over-compliance with the federal GHG program to comply with a portion of the ZEV regulation in model years 2018 through 2021. Yet other than emissions standards and the federal GHG program, CARB does not believe that linking ZEV to other programs makes sense. It is believed that if linked to CAT for example (the equivalent of the Chinese ETS), there will be no added value but rather spillover of credits between the programs in a way that would make management and tracking of air quality outcomes very difficult. Since the two programs are aimed at targeting different type of pollutant sources, manufacturing emissions through CAT and clean auto technology commercialization that reduces GHG through ZEV, linkage was never considered.

For China, two programs may be considered: (1) ETS and, (2) CAFE:

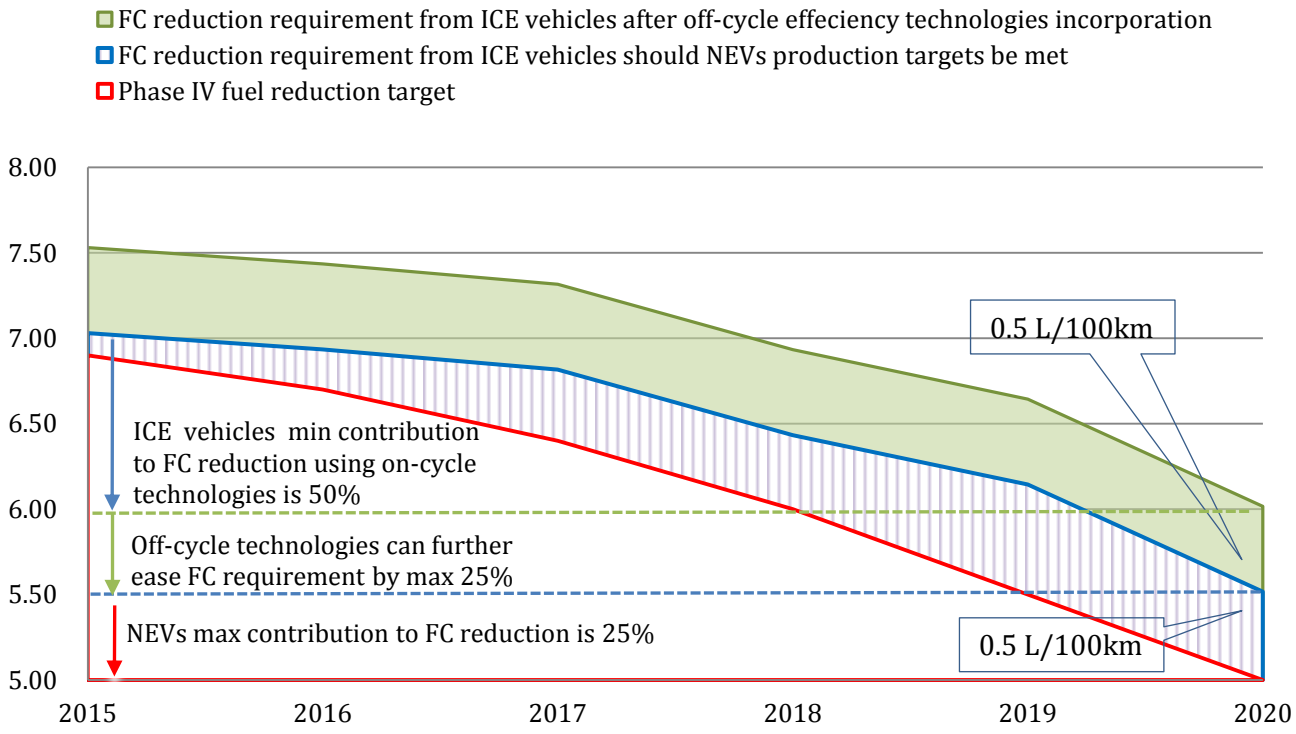
(1) It may be that the momentum built around the expansion of the ETS and the efforts being made for delivering an impactful scheme on the local level, would justify a discussion and evaluation of transformation of ZEV credits to ETS credits and vise-versa. That said, UC Davis working together with CATARC on the China ZEV Policy Lab[17] advises not to merge the schemes, and other Californian experts

[16] http://www.miit.gov.cn/n11293472/n11295057/n11588014/n15609354/16051454.html
[17] http://news.ucdavis.edu/search/news_detail.lasso?id=11006

share the same approach. Hefei government for instance, according to recent media publications[18], is considering the design of a cap on EV and ICE vehicle sales in favor of EVs based on which credits that are tradable in the ETS system could be achieved.

(2) Since trading of credits was initiated for Phase IV of the standard, and it shares a similar objective as the ZEV – tailpipe emissions reduction, there may be room to consider merging of the two programs. If NEVs' cumulative sales reach 5 million units by 2020, their annual production capacity reaches 2 million units, 1.6 million of which are passenger vehicles. As NEVs are counted as zero fuel consumption vehicles, and their annual growth rate has a varying multiplier of 2-5 every year by 2020, resulting in China's 2020 CAFC requirement for conventional technology vehicles reducing about 5.5 L/100km for meeting the overall CAFC target of 5L/100km. The reduction of 0.5L/100km in stringency from China's 2020 CAFC requirement is a result of aggressive introduction of NEV credits. This could contribute to about 25% towards Phase IV CAFC reduction of 1.9L/100km from 6.9L/100km in 2015, and to 5L/100km in 2020. However, there is strong debate regarding the level of incentives required for the inclusion of NEVs into CAFC calculations. The national nature of CAFÉ and the local nature of a potential ZEV credits (at least at the initial stage) impose some design challenges.

China's national NEV goals' projected contribution to the FC standard



[18] http://news.ces.cn/qiche/qicheshichang/2015/06/15/53982_1.shtml

Conclusion

This brief summarizes *i*CET's previous evaluation work of the California ZEV credits mandate and its subsequent correspondence with Chinese stakeholders on issues surrounding the adjustment of the mandate to China. The Q&A structure of the brief and the emphasize of illustration and example figures are meant to make the brief and its suggested inputs for a China-tailored ZEV credits pilot design more easy to read.

A China-tailored ZEV credits mandate requires collaborative effort by national, local and industry experts, and each of these parties should play a role from the initiation phase to the pilot implementation. It is likely that a pilot city would lead the design of a scheme, however its robustness and confidence in the mandate would be strengthen once it receives national support. This brief suggests that local DRCs would be an ideal leader for mandate kick-off and design, however, it is possible that other local players would lead such an effort. A joint task force involving representatives from various governmental entities is advised, and collaboration with third-party players and all spectrum of the NEV industry (not only large manufacturers or locally-based companies) is expected to increase the effectiveness and implement-ability of the mandate in China.

We thank the experts from Chin and abroad that have contributed their comments and shared their thoughts during the writing of this brief. Advocating for trading-based regulation in China for the promotion of zero tailpipe emissions vehicles, iCET plans to continue its efforts on the national and local levels serving as an information provider and engagement enhancer. Your comments and suggestions would be highly appreciated, and your initiatives and/or requests are welcome! Please do not hesitate to contact us at maya.bd@icet.org.cn *or* lpkang@icet.org.cn